

### Electrochemical Cells

This invention relates to electrochemical cells.

5     The invention is particularly, though not exclusively,  
concerned with electrochemical cells of the kind used for  
purification of water and the production of disinfecting  
aqueous solutions. Electrochemical cells of this kind  
10     have been proposed in which an ion-permeable, ceramic  
membrane is interposed between coaxial electrodes, and it  
is one of the object of the present invention to provide  
an improved form of such a cell.

15     According to the present invention there is provided an  
electrochemical cell in which an inner cylindrical  
electrode extends coaxially within a tube of ion-  
permeable material that is mounted coaxially within a  
hollow, cylindrical outer electrode to define inner and  
20     outer annular passageways between the respective  
electrodes and said tube for liquid-flow lengthwise of  
them from one to the other of cup-shape fittings at  
either end of the cell, each cup-shape fitting having two  
inlet/outlet ports that communicate with the inner and  
25     outer passageways respectively, wherein each cup-shape  
fitting defines a cylindrical cavity which has an open-  
mouth that is of a diameter to receive a respective end  
of the outer electrode for liquid-tight sealing  
therewith, said tube projects at each end of the cell  
30     from within the outer electrode into said cavity of the  
fitting at that end and has an annular rim for engagement  
with an internal cylindrical wall of the cavity for  
liquid-tight sealing therewith to separate the inner and  
outer passageways from one another within the fitting,  
and the inner electrode projects at each end of the cell  
35     from said tube into the cavity of the fitting at that  
end.

The outer electrode may be a metal tube, and the inner electrode a metal rod. The metal involved in each case may be titanium, however, where the electrode is for use as the cathode of the cell it may, as an alternative, be of stainless steel. Where the electrode is for use as the anode, it may have a coating (for example, of ruthenium and iridium oxides) that acts as a catalyst in the electrochemical operation of the cell.

The ion-permeable tube may be porous and in this respect may be of a ceramic material, for example composed of aluminium, zirconium and yttrium oxides. The annular rim at each end of the cell may be slidable within the cavity of the fitting at that end to enable sliding of the ion-permeable tube relative to the inner and outer electrodes, and may be provided by a flange of a member that is sealed or otherwise secured to the ion-permeable tube at that end. The extent to which the ion-permeable tube can slide relative to the inner and outer electrodes may be limited by abutment within the cavity at each end of the cell. The abutment may be with a part (for example, a pin or annular rim) that projects laterally into the cavity, or of a longitudinal projection from the tube-end with the bottom of the cavity, or of a longitudinal projection from the bottom of the cavity with the tube-end.

The cavity of each cup-shape fitting may have a stepped internal diameter for defining a first cavity-part leading from the open mouth and a second cavity-part of smaller diameter opening from the first cavity-part. In these circumstances, the ion-permeable tube may project at each end of the cell from within the outer electrode into the first cavity-part of the fitting at that end to have its annular rim engage with the internal cylindrical wall of the first cavity-part. The inlet/outlet ports of

each fitting may open into/from the first and second cavity-parts respectively.

5 An electrochemical cell in accordance with the present invention will now be described, by way of example, with reference to the accompanying drawing, in which:

10 Figure 1 is a part sectional side-elevation of the electrochemical cell according to the invention; and

Figure 2 is an enlarged sectional side-elevation of one end of the electrochemical cell of Figure 1.

15 Referring to Figures 1 and 2, the inner and outer electrodes of the electrochemical cell are formed by a coaxial rod 1 and tube 2 respectively. The rod 1 and tube 2 are of titanium and the inside surface of the tube 2, which is to act as the anode, is coated with ruthenium and iridium oxides that act as a catalyst in the  
20 electrochemical operation of the cell. A porous ceramic tube 3 composed of aluminium, zirconium and yttrium oxides, is supported coaxially between the rod 1 and tube 2 to provide an intermediate ion-permeable membrane for separating the products derived electrochemically at the  
25 two electrodes. More particularly, the tube 3 divides the space between the rod 1 and tube 2 into two coaxial, annular passageways 4 and 5 for liquid-flow lengthwise of the electrodes formed by the rod 1 and tube 2.

30 The passageways 4 and 5 terminate at either end of the cell in sideways-extended inlet/outlet ports 6 and 7, respectively, of individual one-piece plastics fittings 8 (for example, of polypropylene) that are retained on opposite ends 9 of the rod 1. Each fitting 8 is of cup-  
35 shape with a stepped internal diameter that defines a first cylindrical cavity-part 10 into/from which the port 7 opens, and which leads via an annular end-face 11

(Figure 2) into a second cylindrical cavity-part 12 of smaller diameter into/from which the port 6 opens. The ends 13 of the tube 2 are lightly machined externally over a short length (for example, 5 mm) so as to enable  
5 them to be received and provide liquid-tight sealing, in recessed mouths 14 (Figure 2) of the cavity-parts 10 of the fittings 8.

The rod 1, on the other hand, extends axially through  
10 both cavity-parts 10 and 12 of each fitting 8, and has ends 9 of reduced diameter. The end 9 within each fitting 8 projects from the cavity-part 12 into and through a bore 15 of the fitting 8. It is a liquid-tight interference fit within the bore 15 (it may be lightly  
15 machined over a length of, for example, 5 mm, to ensure a constant diameter for the purpose), and is screw-threaded to receive a nut 16 (only one shown, in Figure 1) where it projects from the fitting 8. The nuts 16 are tightened to clamp the fittings 8 firmly onto the two  
20 ends 13 of the tube 2 and hold them to the rod 1 with the rod 1 and tube 2 coaxial with one another.

The tube 3, which projects beyond the ends 13 of the tube 2 within the cavity-part 10, has a radial rim or flange  
25 17 (Figure 2) at each end. Each flange 17 is part of a plastics tubular moulding 18 which is retained on the tube 3 by a plastics sleeve 19 that is heat-shrunk onto the respective end of the tube 3; the dimensioning of the moulding 18 allows for manufacturing tolerances in tube-  
30 diameter. The flange 17 provides a liquid-tight, sliding fit within the internal cylindrical wall of the respective cavity-part 10, separating the passageways 4 and 5 from one another within the fitting 8 at that end.

35 More especially, the extent of projection of the tube 3 beyond the end 13 of the tube 2 within each fitting 8 ensures that the flange 17 is located deeper within the

cavity-part 10 than the port 7 so that it maintains appropriate separation of the port 7 from the cavity-part 12 and port 6. The integrity of this separation is maintained since the freedom of the tube 3 to slide relative to the tube 2 is limited to a small distance (for example, 1 to 2 mm) by the walls 11 at both ends of the cell. However, the freedom for sliding ensures that the clamping forces exerted by the nuts 16 clamping the fittings 8 to the ends 13 of the tube 2 and holding them on the ends 9 of the rod 1, are not exerted on the tube 3. The fact that the somewhat-fragile, ceramic tube 3 is not subject to any clamping force avoids the need to cushion it resiliently.

The attachment of the mouldings 18 to the tube 3 may be by adhesive instead of the heat-shrunk sleeves 19, or by bonding them on by heating the ends of the tube 3 so that the plastics is partially melted as the mouldings 18 are pushed on.

The form of construction of the electrochemical cell described above, has significant advantages of simplicity and economy in that the number of components is reduced as compared with earlier forms, and the extent of machining required is light and limited to the ends 9 of the rod 1 and the ends 13 of the tube 2. Moreover, stock material may be used for the electrodes (for example seam-welded tubing may be used for the tube 2), and the porous ceramic tube 3, which for example, may have a porosity between 50% and 70% with a pore size of between 0.3 and 0.5 microns, is not required to withstand compressional forces or satisfy tight dimensional tolerance-limits. The flanges 17 of the mouldings 18 attached to the ends of the tube 3 provide both the sliding freedom and the liquid-tight sealing required, in a simple manner without any strict dimensional requirement on tube-diameter.